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Suprasternal innominate artery cannulation for reoperative aortic surgery: a technical note

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Abstract

Suprasternal cannulation of the innominate artery in aortic reoperations may be useful in specific situations. Over a period of 3.5 years, 9 patients (6 males, average age = 49.2 ± 16.1 years) underwent suprasternal cannulation prior to resternotomy. Cannulation was performed using a side graft. All operations were successfully completed. Two patients died after surgery because of coagulopathy and multiorgan failure. There were no complications related to access or technique, and no site complications were detected during follow-up. Suprasternal cannulation of the innominate artery may play a role in selected reoperations.

Keywords: Innominate artery • Cannulation site • Reoperation • Aortic surgery

INTRODUCTION

Reoperative surgery in aortic disease is not uncommon in patients with prior operations for the aortic root, ascending aorta or aortic arch and carries higher risk than primary operations [1]. During resternotomy, due to the proximity of the ascending aorta, innominate vein and cardiac chambers to the inner table of the sternum, there may be some risk of injury to these structures. Some authors estimate that ∼4% of patients have aortic injury at the time of resternotomy [2].

Reducing the risk of injury from re-entry, deemed a factor of paramount importance in these cases, can be achieved through the selection of the optimal site for arterial cannulation [3]. Axillary artery cannulation is an established access route for antegrade cerebral perfusion that seems to yield improved neurological outcomes and decreased mortality rates in aortic surgery [1, 3, 4]; however, factors such as obesity and thoracic bony fractures may impede the cannulation of the axillary artery. This technique with or without a side graft is not free from complications, although the experience of the Cleveland Clinic [3] confirms that this is a reliable site; they cannulated the axillary artery 399 times in 392 patients with low morbidity.

In 544 patients undergoing redo operations [4], the risk of eventual re-entry complications (2.7%) included injury to the aorta ($n = 2$), right atrium ($n = 1$), innominate vein ($n = 2$), internal mammary artery ($n = 2$), pulmonary artery ($n = 2$), lung parenchyma ($n = 1$), saphenous vein graft ($n = 2$) and right ventricle ($n = 2$), and ventricular fibrillation ($n = 1$). We report alternative surgical access through direct suprasternal cannulation of the innominate artery (IA) before resternotomy in cases deemed at risk of eventual re-entry injury according to preoperative computed tomography (CT) assessment.

MATERIALS AND METHODS

Study design

This is a technical note on suprasternal cannulation of the IA. A retrospective search of the departmental database, medical charts and data sheets was performed to identify patients who underwent reoperation via this approach.

Study population

Patients who underwent cardiac reoperations at our institution were routinely assessed preoperatively by thoracic CT imaging. Consequently, the patients who had close approximation of the aorta to the inner table of the sternum <3 mm underwent suprasternal cannulation of the IA (Fig. 1A and B).

Surgical technique

The reoperative sternotomy skin incision is extended upwards 2–3 cm through the suprasternal notch. By sharp dissection, the IA

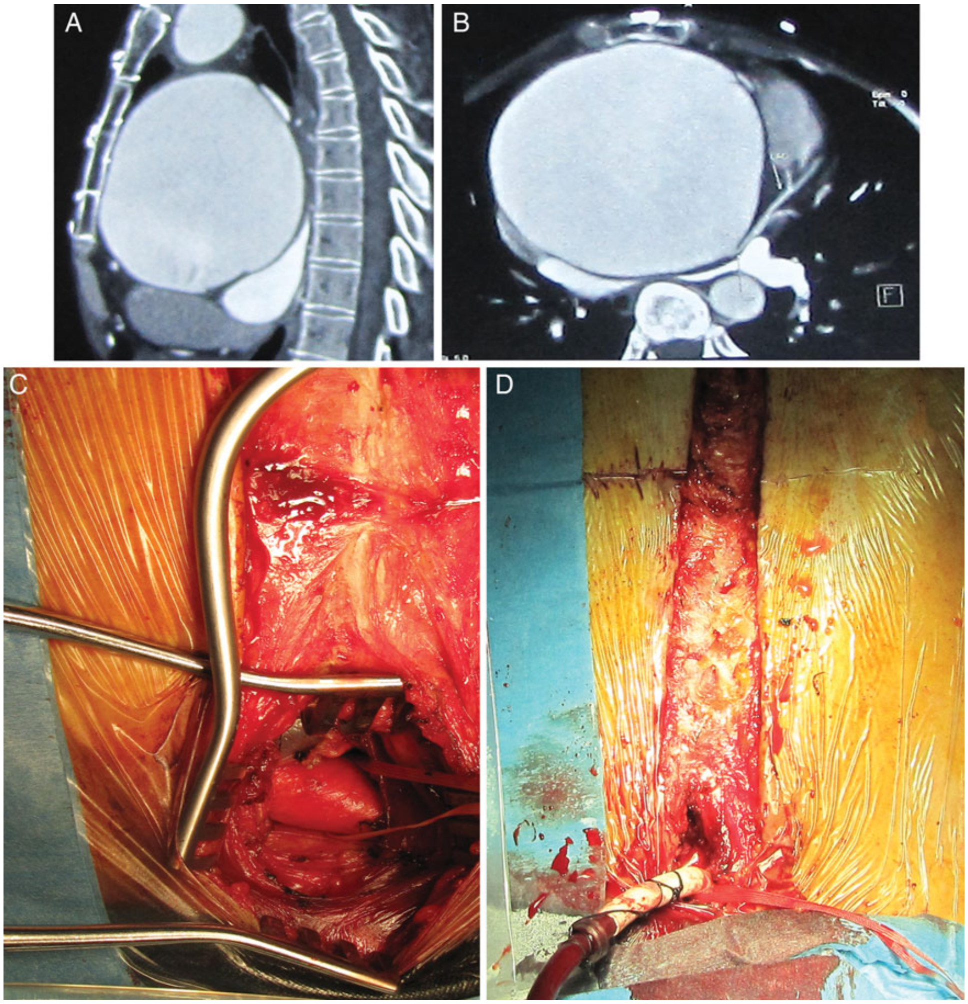

Figure 1: Close approximation of the aorta to the sternum in a case of ascending aortic aneurysm (**A** and **B**); suprasternal innominate artery exploration before resternotomy (**C**) and completed cannulation through a vascular graft (**D**).

is dissected free and taped (Fig. 1C). Then, the IA is temporarily occluded for 2 min and cerebral perfusion is assessed using near-infrared spectroscopy. If there is no significant decrease in cerebral oximetric values, heparin is administered through the intravenous route and an 8-mm vascular graft is anastomosed to the IA. Dacron or polytetrafluoroethylene grafts may be used and sewn with 5/0 running polypropylene sutures. A straight no. 20–22 aortic cannula is then secured to the graft (Fig. 1D). Back-bleeding confirms flow through the cannula at this stage. Next, the patient is placed on cardiopulmonary bypass using femoral vein access for venous return and subsequently cooled to 25°C before resternotomy is attempted. Once the chest is reopened, the operation is completed. After the patient is weaned off cardiopulmonary bypass, the vascular graft is clamped, the anastomosed end is oversewn with 5/0 running polypropylene suture and haemostasis is confirmed.

RESULTS

From April 2012 to October 2015, a total of 265 patients underwent cardiac reoperations at our institution. All reoperated patients were assessed by thoracic CT imaging. Of these, 9 patients (6 males, mean age = 49.2 ± 16.1 years) had close approximation of the aorta to the inner table of the sternum <3 mm. The characteristics of the series are presented in Table 1. Cannulation of the IA was performed following the technique described herein. Seven patients had an uneventful reopening of the chest and 2 cases experienced unexpected aortic injury. In resternotomy without aortic injury, the operation was continued in accordance with the standard protocols of cardiac surgery. The 2 patients who sustained blow-out aortic injury caused by the sternotomy saw received systemic hyperkalaemia (2 mEq/kg potassium chloride intravenously in 2–3 min), with forceful approximation of the sternal edges, for immediate myocardial protection. Thereafter, the IA proximal to the cannulation site was clamped and selective antegrade cerebral perfusion along with body circulatory arrest was immediately started. The operations were successfully completed. No complications related to the cannulation site and methods were detected.

The mean intensive care unit and hospital length of stays were 7.3 ± 3.7 and 20.7 ± 8.9 days, respectively. There were 2 cases of in-hospital death: one patient died due to coagulopathy secondary to ascending aortic prosthetic graft infection and the other one due to multiorgan failure. The remaining 7 patients were discharged in good condition. We followed them up for a mean of 29 ± 23.3 months (range = 6–67 months). There were no complications, either clinical or due to imaging, during the follow-up.

Table 1: Characteristics, intraoperative features and outcomes

Patient	Age (years)	Gender	Prior operations	Indication for surgery	Procedure	CPB (min)	ACC (min)	ICU stay (days)	Hospital stay (days)	Neurological complication
1	65	Male	AVR and aortoplasty	Ascending aortic aneurysm	Ascending aorta and hemiarch replacement	167	78	6	13	No
2	43	Male	Bentall–De Bono operation	Dissection of aortic arch and descending aorta	Arch replacement	262	160	6	22	No
3	44	Male	AVR and aortoplasty	Ascending aortic aneurysm	Bentall–De Bono operation	225	133	4	32	No
4	66	Female	AVR	Aneurysm and dissection of the ascending aorta	Bentall–De Bono Operation	216	86	5	13	No
5	52	Male	Bentall–De Bono operation	Ascending aortic aneurysm	Arch replacement and Bentall–De Bono operation	338	192	6	14	No
6	70	Female	MV malfunction and LA clot removal	Ascending aortic aneurysm, AI and TR	Ascending aortic replacement, AVR and TVR	240	125	12	34	No
7	29	Female	Repair of ventricular septal defect	Subvalvular aortic stenosis	AVR and repairing subvalvular aortic stenosis	200	120	3	10	No
8	50	Male	AVR	Ascending aortic aneurysm	Bentall–De Bono operation	241	129	11	20	No
9	24	Male	TFTC, ascending aortic repair and PVR	Ascending aortic aneurysm and subvalvular aortic stenosis	AVR, PVR, TVR, ascending aortic replacement and PFO closure	336	188	13	28	No

ACC: aortic cross-clamp; AI: aortic insufficiency; AVR: aortic valve replacement; CPB: cardiopulmonary bypass; ICU: intensive care unit; LA: left atrial; MV: mitral valve; PFO: patent foramen ovale; PVR: pulmonary valve replacement; TFTC: tetralogy of Fallot total correction; TR: tricuspid regurgitation; TVR: tricuspid valve replacement.

DISCUSSION

Thoracic re-entry is potentially associated with injuries to mediastinal structures, in particular those adherent to the sternum. Although axillary artery cannulation has been shown to confer improved outcomes [1], there still exists some controversy as to which is the optimal access in reoperations.

An expected advantage of suprasternal cannulation of the IA is the possibility of proximal control of the IA to grant antegrade cerebral perfusion. Cannulation of the IA at the suprasternal level does not preclude additional arterial inflow if required according to the complexity of the case [1, 2–5]. There are no guidelines as to the best approach for thoracic re-entry in cardiac surgery. Experience of the surgical group, number of prior sternotomies, type of disease, existence of prosthetic material in the ascending aorta or prior closure of the pericardium are factors to take into account when resternotomies are planned. Unexpected vascular injury including the aorta at the time of re-entry continues to be a risk regardless of the cannulation plan and may occur in 2–4% of reoperations for complex aortic disease [2, 6]. Cannulation strategies are usually tailored to the patient's pathologic condition and the operative modality. Therefore, controlled studies are difficult to organize. Specific subgroups of patients may be approached in different ways.

Preoperative imaging has been useful to identify cases with mediastinal structures adherent to the sternum. Suprasternal cannulation of the IA may be a helpful tool in specific cardiac reoperations and does not compete with other already established cannulation sites.

Conflict of interest: none declared.

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